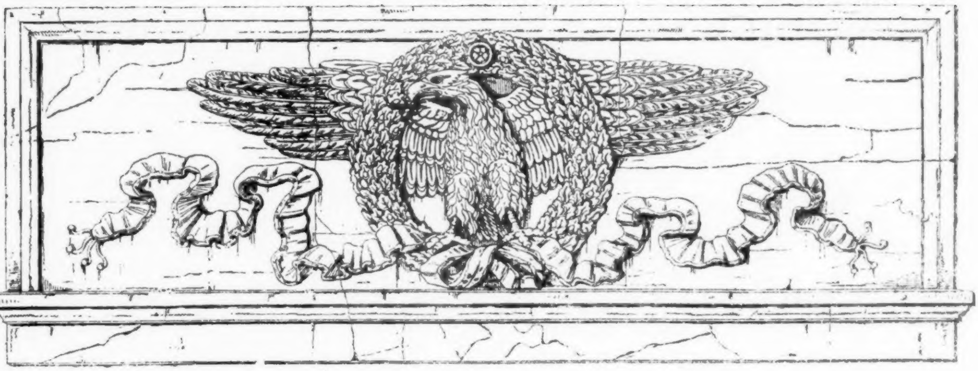


LEADWORK. By F. W. Troup [*F.*] and Lawrence Weaver, F.S.A.

Read before the Royal Institute of British Architects, Monday, 19th March 1906.

I. By F. W. Troup.

THERE has within the last few years been some revival in the use of lead as a material suitable for decorative and ornamental display. It is common knowledge that this metal was widely used in the Middle Ages. The ease with which it could be cast and wrought by hand gave lead a greater position in the earlier days of simple appliances than it could hold to-day, when steel and even wrought iron can be melted and moulded to our will.

Each metal, however, has its own peculiar properties which render it most suitable for certain positions and purposes; and as it frequently falls to the architect to decide which shall be used, it becomes imperative that he should know what these properties are, and why he ought to use lead in one case, cast iron in another, and pewter or copper in a third.

The most prominent qualities of lead are its durability at ordinary temperatures, its ductility, its exceptional weight, and its low melting-point. To bring out these qualities more clearly it has only to be compared with some of the other metals in common use.

Copper and tin are both nearly as durable, but they are four or five times the price of lead. Copper as a roofing material is sometimes cheaper than lead, but that is because the sheets are about a quarter the thickness, and therefore in that proportion less durable, so far as oxidation is concerned. Tin melts at an even lower temperature than lead, and is only a little less ductile. This means that sheet tin would have to be at least twice as thick as copper; and as it is a more valuable metal, this puts it out of court for roofing purposes. It can be, and has been, used with success where cost is not a consideration. Zinc, again, has a somewhat higher melting-point than lead, but it oxidises more rapidly. If used in sheets anything approaching the thickness required for lead, its life would be considerable, as the oxide formed on the surface protects the metal beneath; but although cheaper than copper, it is much dearer than lead, even bulk for bulk. Iron oxidises rapidly, especially wrought iron and steel. Cast iron lasts longer; but even galvanised—that is, protected by a thin coating of zinc—it still rusts in course of time. It is well sometimes to remember that the roofs of the Houses of Parliament are covered with cast-iron plates. Aluminium is almost within our range as a building material. It is extremely light and very durable, but almost as soft as tin, and melts at a comparatively low temperature. It cannot be soldered—a great

drawback to its use in the ordinary arts, but rather an advantage for us if it is ever possible to use it as a roofing material.

From this casual glance at the properties of the principal metals it is clear that whichever we use we must be careful to seize and develop its peculiar qualities, taking advantage of those which suit us and guarding against what may, from this point of view, be called its defects.

Lead wants this care and judgment in its treatment as much as any metal—any material, I might say—for my comparison of the qualities of lead might easily have extended beyond the list of metals only.

For fifty or sixty years of last century lead was almost entirely relegated to the most utilitarian of purposes. A lead roof to all intents meant a flat roof—one that only birds can see. The worker in lead became a "registered plumber," whose chief glory was his knowledge of drains; he became a sanitary scientist. His skill, however, as a craftsman in the mere manipulation of lead was and is unsurpassed. What he had lost was a loss common to all the trades, as the crafts have rightly come to be called—namely, the skill to play, to sing, and to laugh—in fact, to write a poem with his material. That power, since we cut adrift from tradition, seems to be gone for ever; and whether a new tradition can ever again be formed very much depends upon whether we can resist the vagaries of fashion and the efforts of the self-conscious genius vainly searching after some new thing.

Nevertheless here we are, like it or not as we may, and our bounden duty is to do the best we can with what comes to our hand in men and materials; and milled lead is one of the first things that comes to our hand, but a dull and pasty material compared with lead run out in the old way by casting the molten metal on a sand bed to the actual thickness required for use. The art of casting has never been entirely abandoned. Cast sheets have always been used for lighthouse work, and many of the cathedrals kept up the old practice, and some do so still. Luckily we are not always restricted to milled lead; cast sheet can easily be bought in the open market at the present day. It sells at a rather higher price than milled sheet of the same weight. The sheets are naturally not quite so even in thickness, and therefore a heavier average weight must be used in order that the minimum thickness shall be equal to the unvarying thickness of the machine-produced sheets.

For a flat lead roof, often liable to be walked upon, there is not much to be gained from using cast sheets. A lead flat is not part of a building that, as a rule, is much seen, else the surface texture of the cast sheet is worth making some slight sacrifice to obtain, especially if the old-fashioned open roll or flat welt-roll can be used. Either of those joints is preferable to the usual modern roll with its wooden core. The wood roll has to be large, and therefore clumsy; else we have leaks arising from capillary attraction between the sheets. The open roll has not this defect, but cannot, of course, stand under much foot traffic. When lead is used, as in a spire or turret, it is then certainly worth while to use cast sheet. Even with a wooden core in the rolls the cast sheets do not cause suction to such an extent as milled lead.

Lead, again, neither milled nor cast, should be laid directly upon oak unless the latter, in order to get rid of the sap, has been soaked for some weeks or months in fresh water. In the form of planks a week or two is sufficient; but in the log it must lie much longer, and then stand on end to assist the draining out of the fluids.

The natural surface of the lead as it is cast is the best to use as the exposed surface in a roof or elsewhere. When there is ornament of any sort to be cast with the sheet, then the under or sand surface must be exposed; there is then no choice. This can be as rough as you like, for roofs or rain-water heads and a coarse sand may be then used for the casting bed. But for things which come close to the eye, or which may be handled, a much

finer sand should be used. More care is then required in the casting to provide for the escape of the steam formed by the molten metal on the damp sand. For a "repeat" ornament, or for casting letters and figures for dates, a lead mould can be used. This is easily made and lasts for a long time, but brass or cast iron gives a more permanent article. For knobs and finials it is possible with a lead or brass mould to fill it with molten lead, and after two or three seconds empty out the interior unsolidified lead, giving a hollow casting without the trouble and expense of making a core as for a brass or iron casting. Even such things as soil-pipe traps used to be cast in this way, although now these are usually squeezed out by an uneven but controllable hydraulic pressure which forces the tube to right or to left as the lead exudes from the orifice. Lead, however, is so easy to twist and turn into decorative forms and to cast into ornamental patterns that I would counsel designers to use some restraint. As it is but a step from the sublime to the ridiculous, so it is from legitimate beauty to the nauseation of excessive ornament. With this danger in view I venture to urge designers never to forget their material; do not design a thing to look well on paper. Use paper if it must be, but only as a means to an end; and, even in modelling, the final material must never be lost sight of. It is quite possible to make a casting from a single pattern in several different materials, but to take full advantage of the best that can be got out of each material that original pattern ought really to be varied in each case. For a plaster cast, for example, you may have moderately high relief; but it should be soft in contour, and there is no special reason for economy in material. In lead there is great reason for economy of material, and you can have finer lines, and can reckon on bending, soldering, or even to some extent bossing up your casting after it is made. In cast iron, besides having shrinkage and fracture to consider, you have in it some of the qualities of both the other materials; but it cannot be bent like lead, nor trimmed and cut with the same ease as a plaster cast.

To return to lead for a moment, there are several other ways of ornamenting it besides by casting it in moulds or in damp sand which has been moulded by patterns or stamps.

It is very easy to make fretwork patterns for ventilating panes in windows or as a vallance round a leaded dormer or door-hood. This is certainly best done with chisels and gouges on a block of lead. The chisel should be wet, as any plumber's boy knows who has got to the length of cutting a sheet of lead with a draw-knife.

Lead can also be incised and the incised lines filled with various coloured mastics in letters or what shapes you will.

One of the most gorgeous possibilities for decoration in lead is to be had by tinning the metal in some design of ornamental or figure decoration and then glazing over the tin surface with transparent colours. How long these colours last I am unable to say, but the tinned ground on which it is laid is permanent, and the colour can thus, without great difficulty, be renewed, especially if the figures are, as they used to be, outlined with broad incised lines filled with black mastic.

I have said little in these remarks about what was, after all, the chief method of working lead and using it in the buildings of the Middle Ages. This was simply to take the plain cast sheets, and after cutting it to the outline as near as might be, and in convenient size for handling, to dress, boss, and beat it up to the shape required. Sometimes these forms were carried on wooden cores; at other times on a framework of iron, or were simply fixed by iron hooks and brackets on the timber framing. This art is as dead as Queen Anne. It is a personal art like sculpture—very often it was sculpture—and no amount of designing by another for the craftsman to execute will do much to restore it. So far as manipulation of the metal is concerned, the skill and knowledge to work lead are still with us. Anyone who

goes to see the exhibits of the many technical classes can see for himself perfect miracles of what can be done in beaten lead, but they are mere *tours-de-force*. The art has been so long divorced from the craftsmanship, and the teaching of tradition so long deserted, that their reunion is hardly a matter to be accomplished in a single generation. We can but live in hope.

I must not, however, detain you longer. My colleague has many things to show you and tell you about—examples, monumental examples, of what has been done in this country in leadwork. We cannot perhaps boast such gorgeous shows of leadwork as are to be found in France; but for beauty of proportion and design some of the English lead-covered spires are hard to beat, and the numerous examples remaining will be a surprise to many.

II. THE EARLIER LEAD SPIRES. By Lawrence Weaver, F.S.A.

IT seems to me that anyone reading a Paper on leadwork before so distinguished an architectural gathering should have at least one of two qualifications: he should be either an architect or a lead-worker. Mr. Troup is both. I am neither. I am only an antiquary, and I confess that the high respect which I have always felt for this Royal Institute was painfully reduced when you did me the honour to ask me for a Paper on a subject about which I can obviously know nothing.

I beg, however, that all complaints may be addressed to the President. I have already arranged that Mr. Troup shall answer all the awkward questions.

As to a subject, I felt that to range vaguely over leadwork generally would be useless in the time at my disposal. I am already somewhat on record in the matter of pipe heads, cisterns, statues, and fonts, and I will therefore confine my wearying remarks to leaded spires, and amongst them to the Gothic examples only. The Wren spires made such a break in the traditional forms that they make a separate subject.

Lead has certainly no worthier use than in roofing. It equally certainly has no nobler use than in the covering of spires, for spires are the greatest concession that Gothic architecture has made to constructed beauty and symbolism; and amongst them the lead-covered timber spire takes an honoured, if a small and rather forgotten, place. The lead spire has a character all its own, and maintains its character of a spiritualised roof more intelligibly than a stone spire can do. The white, almost glistening, patina which comes with age on lead, where air is not befouled with smoke of cities, makes the spire stand like a frosted spear against the sky, and the slight twists, which almost every timber spire has taken, give a peculiar sense of life. These are "refinements" which do not fit into Mr. Goodyear's theories, but result from the sun sporting with a slender timber structure, made more sensitive by its metal coat. A shingled spire is apt to twist (Cleobury St. Mortimer is an example); but there is none shingled that compares with the inebriate vagaries of the lead spire of Chesterfield.

One of the most interesting points that arises with lead spires, as indeed with all subjects, is the question of origins, and in this connection I must mention shingled as well as leaded timber spires. Mr. Francis Bond in *Gothic Architecture in England* takes some pains to classify spires of all types. He divides them into Pathless and Parapetted spires. The pathless he divides again into Class I., timber spires, and Class II., broach spires. As a subdivision of timber spires he includes those spires built in stone which are yet of the timber type, such as St. Kyneburga, Castor, Northants. Among the timber spires which he gives under his "Pathless" heading I will deal with the following:

a. Shere, Tangmere, Merstham, Newhaven, Plumpton. These are shingled, and may be taken as the first remove from spires square on plan, which are simply lofty roofs. I propose to identify them as the "collar-type." They are of a form equally appropriate to lead and to shingled coverings. Octagonal in their upper portions, the diagonal sides spread and bend outwards to the corners of the tower, which they meet in a point. The vertical timbers of the octagon are framed in a collar which is supported by the timbers of the lower part.

b. Ryton, Northumberland, is strictly of this collar-type, but leaded, the angle between the lower and the upper parts of the spire being, however, much more obtuse, and resembling rather, in general proportions, the Braunton broach.

c. Godalming is not of this type of pathless spires, but a pure broach, and should have been in Mr. Bond's Class II.

d. Hemel Hempstead, Wickham Market, Walsingham, Chesterfield, and Harrow are not even pathless, but parapetted spires, which stand within the wall line of their towers, and should have been in Mr. Bond's Class III. Moreover, none of the last four has a collar. All run down straight from top to base.

I now offer an amended classification for lead spires, based on Mr. Bond's, but corrected.

Pathless.— I. Collar-type, *e.g.* Ryton.
II. Broach-type, *e.g.* Braunton, Barnstaple, Godalming, Ickleton, Swymbridge, Almondsbury.
III. Pinnacled type, *e.g.* Long Sutton, and St. Nicholas, Aberdeen.

Parapetted.— I. Collar-type, *e.g.* St. John's, Perth, the tower of which has a heavy oversailing parapet within which the spire stands.
II. Broach-type, *e.g.* Hemel Hempstead.
III. Straight-sided type, *e.g.* Harrow, Chesterfield, Minster, Great Baddow, Much Wenlock, Wickham Market.
IV. Spirelets, *e.g.* East Harling, Wenden Ambo, Swaffham, Hitchin, Sawbridgeworth, and Ash, Kent.

A certain difficulty arises in the definition of lead spires owing to the somewhat loose use of the word "broach." The type which I call "collar-type" is sometimes called "broach," but incorrectly.

The essence of the broach I take to be that the filling-in between the angles of the tower and the diagonal faces of the spire shall be of pyramidal form. Mr. Bond says, when dealing with broach spires: "Just as the timber spire-form was copied in stone, so the stone broach was copied in wood, *e.g.* at Braunton, Devon." He does not, however, point out that there are more broach-type than collar-type pathless leaded spires. One must, however, concede the collar-type as being the original and natural form for a timber spire. Mr. Prior, in his *History of Gothic Art in England*, writes of "wooden lead-covered spires, first the models and then the copies of the stone." And again: "Almondsbury, Gloucestershire, Hemel Hempstead, Hertfordshire, and Braunton, which, being wood and lead reproductions of the Northamptonshire 'broach,' may be conjectured as originally due to its influence."

So much may be admitted without suggesting that the lead broach is a slavish or unintelligent copy of the stone broach. It is a question of carpentry. The construction of the collar-type is more congenial to wood than is the broach. The octagonal framing calls (but not, I think, very urgently) for strutting at the base. In the broach the main framing is strutted by single timbers running through the diagonal faces of the octagon; and this is not so satisfactory as the double strutting of the cardinal faces, which obtains in the collar-type.

I am inclined to look at the question rather from the point of view of weathering. The builder of lead spires had a simple problem to face. He had to put an octagonal spire on a square tower, and to provide a weathering from the diagonal faces of the spire to the angles of the tower. In the case of shingled spires he elected to construct what I have called the collar-type; in the case of leaded spires he used both the collar-type and the broach-type, but the latter more commonly.

While it is true that in stone broach spires the pyramidal broach, borne on a squinch, buttressed the spire and had an important constructional function, it seems equally true that in timber spires the constructional significance of the broach- or collar-type is less marked.

From the weathering point of view, the broach-type is as efficient as the collar-type, and I feel strongly that the broach is far the more attractive.

Regarding the question of development, Mr. Prior's view that the lead broach was inspired by the rise of the Northamptonshire stone broach is confirmed geographically. The leaded spires of broach-type in Devonshire, Gloucestershire, and Surrey are comparatively near Northamptonshire, while the furthest lead spires—viz. Ryton, Northumberland, and St. John's, Perth—are of the collar-type.

The question is hardly helped by considering the drawings that remain of the destroyed cathedral spires in Dugdale and elsewhere, as they are profoundly unreliable in detail.

The history of destroyed lead spires is a fascinating one, but I have no time to refer to any but that of Lincoln, and to that only by reason of what survives. I illustrate the central tower on which the pinnacles are leaded, melancholy reminders of the glorious spire which has gone. The pinnacles are probably restorations done at the time when the flimsy stone battlements were done by Essex in 1775.

I illustrate another notable detail of Lincoln in the lead-covered wood parapet, which from the ground looks like stone. It is only on the west side of the south-east transept, and exactly copies the bulk of the parapets, which are, of course, in stone.

Before I leave cathedral leadwork I would mention the lead cresting from Exeter Cathedral, and note that the same fleur-de-lys form persisted, long after the Gothic spirit was dead, as an ornament to the edges of the Aberdeen spires.

I will now deal in a little detail with some examples of the different types I have classified.

Of Class I., pathless collar-type, Ryton shows a very irregular meeting of the diagonal ribs on the faces of the octagon.

Of Class II., pathless broach, Almondsbury has, for its height, very small broaches: they strike the diagonal faces at a comparatively acute angle.

With regard to the leading, the sheets are narrow, and the diagonal arrangement of the rolls is carried down to the base of the spire. There are no spire lights, but very small openings for ventilation near the top. At Braunton, Devon, however, there are gabled vertical spire lights with luffer boards, and the rolls are gradually worked from a diagonal arrangement to the horizontal, half-way down the spire lights, a treatment which adds much interest. At Barnstaple the spire lights are a still more notable feature than at Braunton. I think Barnstaple the finest existing broach. At Swymbridge (like Braunton, near Barnstaple) the spire has gabled lights similar to Braunton, but the spire was restored a few years ago, and I cannot say whether it is now as it originally was.

Ickleton, Cambridgeshire, has a remarkable spire. It is very low compared with the height of the tower, and has an odd treatment.

The chief characteristic of the collar-type of shingled spire is that the sides do not run down straight from the apex to the base, resting on the tower wall. At the collar the line

both of the cardinal and of the diagonal sides breaks outwards. This is true of Merstham, Pembury, Plumpton, Tangmere, and Newhaven, all shingled. It is also true of St. John's, Perth, leaded collar-type. It is, however, not the case with Hadleigh, Suffolk, and Ryton, Northumberland, both leaded collar-type.

The peculiarity of Ickleton is that, though it is broach-type, the sides break outward about half-way down the broach itself, and so give it a strong superficial resemblance to such shingled spires as Merstham. Ickleton is the only leaded broach which has come under my notice which presents this peculiarity. It is, in fact, a compromise between the broach- and collar-types, and goes, I think, to help my contention that the actual broach is as natural an angle finish for a timber as it is for a stone spire. Ickleton spire is of date 1351. Godalming spire is of beautiful proportion and a little twisted.

Of Class III., pathless pinnacled spires, Long Sutton is, I believe, the only surviving English example.

I turn now to the parapetted spires, Class I., collar-type. The spire of St. John's, Perth, is unusual in that it is of collar-type standing within the tower walls, and the parapet is heavily corbelled out. In proportion to the tower it is very low and squat. There is a mass of information with regard to Scottish spires with which I shall shortly be dealing in the *Burlington Magazine*.

Of the parapetted broach-type Hemel Hempstead is not a very convincing example, since the parapet covers all but the top of the broach, and the spire looks straight-sided. I have not had an opportunity of inspecting it, and but for Mr. Prior's mention of it as a broach I should from a mere examination of the photograph have blundered into describing it as a straight-sided spire.

Of Class III. of the parapetted type, the straight-sided spires, Great Baddow, Essex, is notable for its economy of rolls. On each face there is only one roll between the angle rolls, and this ceases at the fourth horizontal division from the top. The little bellcote is an interesting addition, but, I imagine, quite recent.

Harrow, on the other hand, is prodigal of rolls, there being three on each face between the angle rolls. The spire is of the fifteenth century. On the lead near the base of the spire are writ large the names of the churchwardens of 1823 under whom the spire was repaired, and, curiously enough, also the legend, "Hannah Patman, plumber, 1823." This lead-working lady was carrying on the business of her deceased husband.

Minster is another of the spires with vertical rolls only.

Wickham Market's special interest is that it is an octagonal spire on an octagonal tower.

Of Chesterfield I need say little—it is so well known—save to point out that the rolls are of herring-bone arrangement, as is more common with pathless spires, while vertical rolls are more usual with parapetted examples.

Of the parapetted spirelets, which I have called Class IV., there are numerous examples. These engaging little spikes have obviously no justification except a purely decorative one. To people who want to justify everything a broach- or collar-type spire is a roof, and bells can be hung on it. For the large plain spire standing within a parapet there is less excuse, and for the spirelet none at all.

The spire of East Harling, which dates from 1450, is not only the most ambitious in England from the lead-worker's point of view, but, I think, the most beautiful. The spire proper stands on an octagonal drum with vertical sides, also leaded. This conjunction of spire and drum is an imitation *in petto* of the octagonal intermediate stage between tower and spire that we find in stone at Wilby and Exton. There is in Dugdale a drawing of a very notable feature of Hulm Abbey, Norfolk, which is of cognate character. I reproduce it.

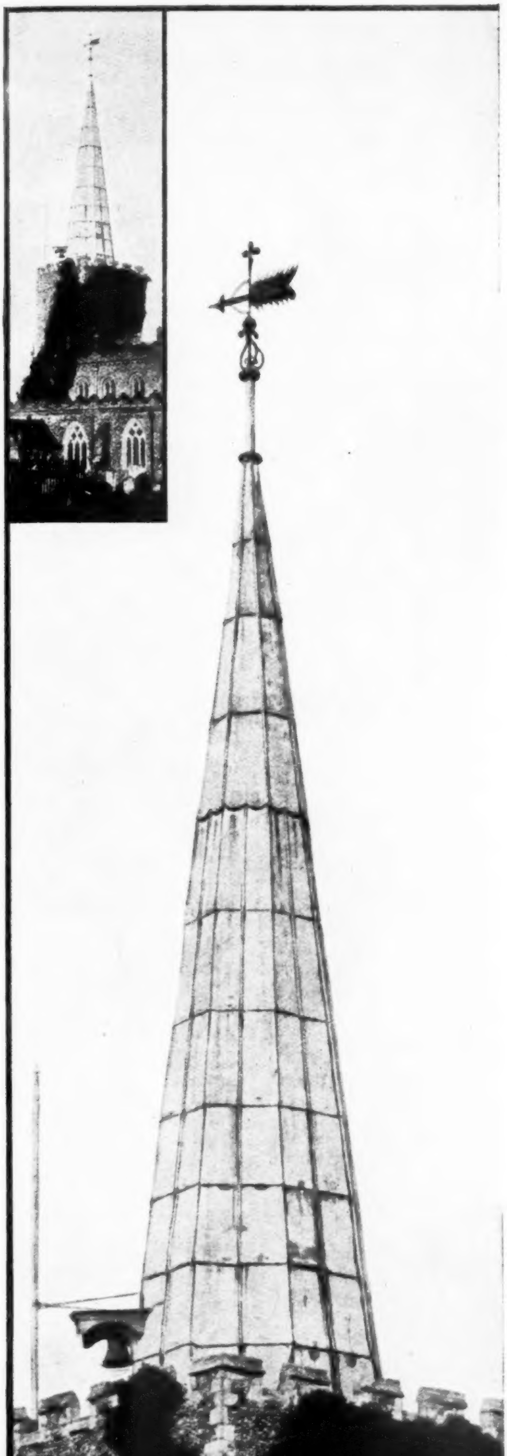
The lower stage of the spire appears to have been circular and altogether leaded. It is in a general way the ancestor of the East Harling treatment.

The spirelet of Swaffham is very interesting, if late. It has also been restored, in 1896, by Mr. W. O. Milne, but so piously as to rob the word "restoration" of its sting. The history of the spire, as kindly given me by Mr. Milne, is so interesting as to deserve extended mention. The tower is of 1507–1510. It is not known whether a spire was built then, but I conjecture not. I incline to date the first spire about 1600. In 1777 the spire was taken down because, as the vestry minutes state, it was observed to be out of perpendicular. Upon this one of the churchwardens and the vicar employed Mr. W. Ivory, an eminent architect of Norwich, and Mr. Robert Treegard, of London, a retired builder, to take a survey of the spire. After survey they reported that the spire was dangerous and must be taken down. A vestry meeting then made order that Mr. Frost, carpenter, "do forthwith repair the spire at an expense of £80." Apparently the joint wisdom of the eminent architect and the retired builder was flouted, and the spire only ordered to be repaired. The strenuous Mr. Frost, however, "without further application to the wardens, proceeded to take the spire down entirely and to rebuild another."

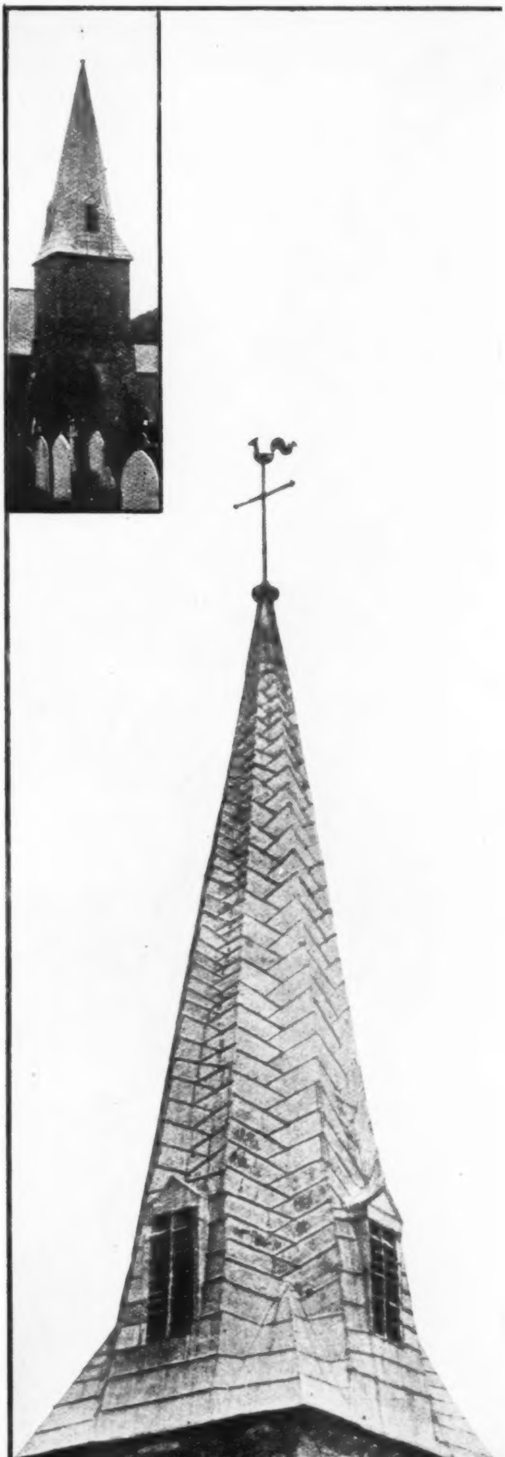
In 1778 the wardens are presented with a bill for £437 0*s*. 5½*d*., the 5½*d*. doubtless for moral and intellectual damage consequent on the original contract only having been for £80. After much wrangling they settled for £387 0*s*. 5½*d*. One feels that Mr. Frost's honour was secure. He gave away £50, but he triumphs with 5½*d*.—altogether a charming picture of the engaging ways of contractors in the eighteenth century! To return to the spire itself. The drum was not taken down in 1896, though some of the decayed timbers were replaced by new. The open oak arcading was entirely renewed, the old work being very debased—doubtless some of our friend Mr. Frost's work. The upper part of the spire has been rebuilt to precisely the same dimensions and details as before. By far the most interesting feature, however, is the ornamentation of the drum. Cross keys and swords are surrounded with a moulding, egg-shape in outline, and 1½ inch thick. These doubtless came from the spire which Mr. Frost pulled down, as they were simply fixed by two large iron nails, assisted by two hooks at the top to hang them in position. They have been refixed with every care. I doubt not that such ornaments as these were common features of mediæval lead spires, and have disappeared as the spires which now exist were repaired and releaded.

Having dealt so far with the history of lead spires, I now venture something by way of constructive criticism. Mr. Lethaby when dealing with lead as a roofing material points out that metal architecture was in early days the architecture of the poets. That is hardly its character to-day. After Charing Cross we look to the coroner rather than to the poet. It is unquestionable, however, that much thought has been given to the use of iron construction, if haply it might be made as beautiful as it is often useful. People have gibed, and justly, at the papering with stone of the steel skeleton of the Tower Bridge and similar structures. Critics of architecture have laid down with dogmatic impressiveness that, concealed in the womb of time, there must be an adequate steel architecture which shall be æsthetically satisfying. The architectural heavens have been loudly invoked that a Wren may arise who shall do this thing and bring in a new era. The hypothetical Wren, however, lingers.

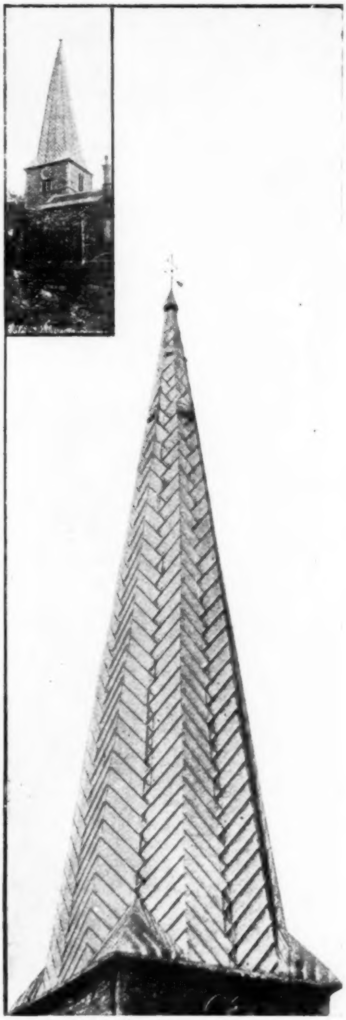
Now I trust that my illustrations have shown how beautiful lead spires can be and are. We cannot doubt that they held a high place in the affections of the mediæval architect. The lead gave him no trouble: he gained infinite variety of surface by different arrangements of the rolls; he outlined great cartoons on the faces of his spires (as at Chalons-sur-Marne), and blazoned them with gold and colours; he wanted the metal-cased architecture of the poets, and he got it—his difficulty was that he could not keep it. His timber framing was



GREAT BADDOW, ESSEX.



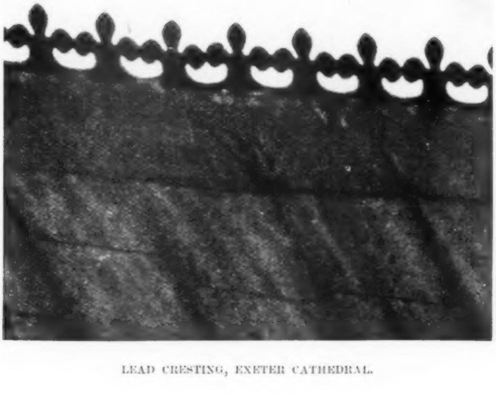
BRAUNTON, DEVONSHIRE.



ALMONDSBURY, GLOS.

RYTON, NORTHUMBERLAND.

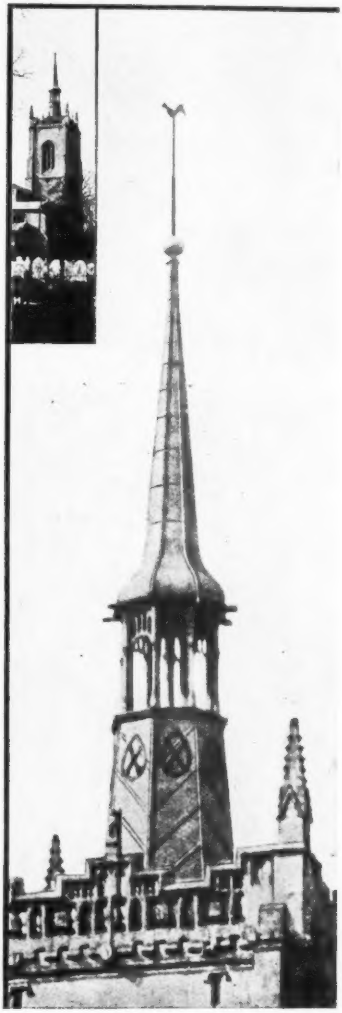
ICKLETON, CAMBS.



LEAD CRESTING, EXETER CATHEDRAL.

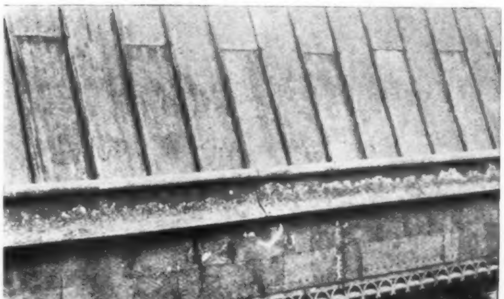
HARROW, MIDDLESEX.

HULM ABBEY, NORFOLK.
(From Dugdale's *Monasticon Anglicanum.*)



SWAFFHAM, NORFOLK.

CENTRAL TOWER, LINCOLN CATHEDRAL.



LEADED PARAPET, LINCOLN CATHEDRAL.

DIE BLEIERN KIRCHE, STRELSAU. (SIR CHARLES NICHOLSON, *inv. et del.*)

in danger of fire from above and fire from below. Lightning conductors have minimised, if they have not rendered impossible, the former disaster, but there is always the danger to a timber spire from fire arising in the belfry-stage or in the body of the church. After a timber spire had been burned down once or twice and rebuilt, and then burned down again, even the desire for a metal-covered spire gave way before motives of economy, and stone replaced the timber and lead.

To-day there is an alternative. Our spires can be built in steel and sheathed in lead, and will defy the flames. I suggest that here is a field where there is room for effort and the possibility of notable achievement. I do not make any suggestions as to the precise form the steel skeleton shall take, or what material shall be intermediate between steel and lead. These points are matters of detail. The construction should present no difficulties. The spire has but to carry itself. I am concerned rather to emphasise the fact that here is one field, not unimportant even if it be small, where steelwork may come into its own; may come faithfully and gracefully; may be the metal bones of a metal architecture. I claim for it that it preserves the initial idea of a spire that it is a glorified roof; that the lead surface gives opportunities for colour treatment that a stone spire cannot give. I believe that, had the mediæval architect found the material to his hand, we should be pointing to-day to his leaded steel spires as notable examples of the Gothic spirit. But I can happily do more than babble of these things. I can show you a design for a leaded steel tower. This my friend Sir Charles Nicholson has done to illustrate my suggestion, and I am sure you will add your thanks to mine for his kindness in backing my lame words with his strong and brilliant brush and pencil. It will not be attributed to my gratitude and to my friendship for him, that I describe this Bleiern Kirche as instinct with the poetry and mystery which are the characteristics of great architecture. I can only hope that some ecclesiastical Mæcenas will be found, for whom Sir Charles can materialise this dream church encrowned with lead. So far it has only been built in Strelsau, and its date is February 1906. Strelsau—so Sir Charles tells me—is little visited by architectural tourists, and you can book tickets only at 2, New Square, Lincoln's Inn; but when you get there (if you take an introduction from Mr. Anthony Hope), the natives will tell you of the Prisoner of Zenda, and you may perchance make a measured drawing of Rudolf's tomb.

Finally, I have to express to you my sincere condolences on a severe loss which you (and, indeed, I) have suffered this evening. The fact is, that I am to be regarded merely as an unhappy makeshift. A Paper on leadwork should instead have been read to you by your distinguished Fellow Mr. Lethaby, who is to me, as to all interested in leadwork, both the law and the prophets. Had Mr. Lethaby discoursed to you, he would have presented to you the philosophy of leadwork in the luminous fashion which is his happy gift. He would have shown you the spirit of leadwork. I, save in the case of the Bleiern Kirche, have but paraded before you its bones.

I am greatly indebted for permission to reproduce photographs to Miss E. Morton (Almondsbury), A. R. Goddard, Esq. (Ickleton), B. H. Bedell, Esq. (Lincoln parapet). The Braunton and Exeter prints are from my collection of leadwork photographs taken by Mr. W. Galsworthy Davie. The Ryton print is by Messrs. Valentine.

DISCUSSION OF THE FOREGOING PAPERS.

Mr. Edwin T. Hall, *Vice-President*, in the Chair.

Colonel LENOX PRENDERGAST [*H.A.*], who rose at the instance of the Chairman to move a vote of thanks for the Papers, said he should like to adopt in a different sense the words that fell from the last speaker at the opening of his most interesting lecture, viz., that he had undertaken the subject before them, not as an architect, nor as a worker. He confessed that he found himself in the same position, without the knowledge of which they had just had so faithful an exposition. The subject brought before them that evening had been to him of the greatest possible satisfaction, for it was a little out of their usual groove. Many came to their meetings who knew as much as was being told them; but he doubted if there were many present who knew much about leadwork in its artistic sense; yet there were few great architectural works throughout Europe that were not indebted for their beauty to the utilisation of various forms of leadwork. The uninitiated little knew the extreme value of the material used architecturally. He himself was not an architect; he had, however, the honour of being an Associate of their great Institute, and therefore might be presumed to have some love for the art; but he never went down to Westminster without wondering that this great country, which possessed one of the most interesting and most remarkable halls, that had existed nearly five hundred years, could leave it standing in front of the great Abbey, with its present ramshackle roof, instead of the glorious leaden roof that ought to replace it. It was astounding to him that a country which professed to have some love for art and for architecture should be unable to realise that such a splendid building lacked its appropriate crowning, and was absolutely ruined in its present position for want of its leaden roof. The great architect who built the Houses of Parliament never meant in his plans that that hall should show itself; but his masters having chosen to alter his plan, and to expose the building, their first duty was to give it a leaden roof, which alone could make Westminster Hall look what it ought to be. The Papers had given them most valuable information in the first instance on the technical side, and, in the second, although it was modestly repudiated by the lecturer, on the architectural side also; they would prove, he was sure, of the greatest possible service to architects. As regards Chesterfield spire, it was now fifty years since he first saw it, and he noted the epithets applied to it that evening as to its inebriated twistings. He had years ago endeavoured to ascertain the reason of its extraordinary form, and the conclusion he had arrived at from the information he had been able to obtain from local experts at the time was that the thing was deliberately done. He doubted if any twistings by nature could have produced it. This double-barrelled lecture, as he might call it, appealed particularly to him, and he had come down at some trouble expressly to hear it. They had had both sides of the question put before them in as able and pleasant a manner as it was possible to receive it, and he begged to move that they offer their best thanks to the lecturers.

Mr. H. V. LANCHESTER [*A.*], in seconding the vote, said there were two points about which he should like to ask questions. It would be interesting if Mr. Troup could give them a little more information as to the exact method of tinning, or the application of other metals to lead. The other point was raised by Mr. Weaver—viz., as to a suitable method of putting lead on a construction other than wood. That would be a great help to them. It was not necessary to plead the cause of lead before architects: they all liked it, particularly for the fine conjunction it made with certain stones, such as Portland stone. The beautiful harmony of colour between old lead and Portland stone was not obtainable by any other such dissimilar materials. What he desired to know was whether they could get a thoroughly fire-proof construction, like reinforced concrete, and attach lead to it in a satisfactory way. Mr. Troup had had more experience in the material than most of them; and they would be glad to have the result of his researches.

Sir CHARLES NICHOLSON [*F.*] said he should like to know what timber was used at Chesterfield. He always understood that the twisting of the steeple was due to the green timber used in its construction. Possibly a good deal of elm might have been used in it, and elm was very apt to twist and curl up. If elm was used, that would account for the twisting.

Mr. C. HARRISON TOWNSEND [*F.*] said he wished very heartily to support the vote of thanks. Reference had been made to one who was well known as an artist who had helped very much to revive the interest in the craft of working in lead—viz. Professor Lethaby. A still earlier worker in the field was the late Mr. Eden Nesfield. Those who, like himself, had been privileged to work alongside Nesfield would remember how keenly he sought to revive the interest in lead and to make artistic use of it, and this, too, at a time—some twenty-five or thirty years ago—when the material was simply used for

plumber's work. He remembered, for instance, a work at Babbicombe, he thought—but Sir Charles Nicholson could confirm him in this—where Nesfield introduced lead cornices with moulded and cast incidents supporting them at intervals, a lead parapet divided into panels, of which each was enriched with a different *motif*, and which ran the whole length of the building. This, he repeated, was at a time when lead was by the rest of his fellow architects undreamt of as a material to do anything but cover a lead flat with. He was glad of the opportunity to draw attention again to the work of one who was a master in his art, but whose work had not received the recognition one might have hoped it would.

Mr. MAURICE B. ADAMS [*F.*] said it occurred to him the other day, in dealing with a matter where lead and iron came together, that it would not be a bad thing to utilise uralite. He proposed to use uralite in this case as a material to insulate the iron from the lead. He did not know whether Mr. Troup had ever thought of that, or whether anyone else had so used it; but he (Mr. Adams) would suggest that the necessity of keeping lead away from iron might be readily overcome by strips of uralite. This material was extremely hard, and could be screwed through and cut like wood. It was composed of asbestos, and he thought no chemical action could possibly take place between the lead and the iron with a sheet of uralite intervening. It was always well to keep such new materials before one. He could well imagine that in a spire of steel or reinforced concrete, as Mr. Lanchester had suggested, where the steel would necessarily crop up more or less towards the surface, and where it would be perhaps unwise to use lead without some intervening material, uralite might be usefully employed. The necessity of protecting sheet lead against the action of oak was never more forcibly demonstrated than in the new lantern over the crossing at Ely Cathedral. A comparatively short time after that was put up, if he remembered rightly, the lead was so disintegrated that it all had to be re-erected. He was sure that no one could speak on an occasion like the present without offering sincere congratulations to the lecturers, and also to the Institute, for having brought about so very pleasant and valuable an opportunity for discussing an artistic and practical subject.

Mr. E. W. HUDSON [*A.*] said he should like to be associated with the vote of thanks. They had all thoroughly enjoyed the lectures, and the examples that had been brought before them were to many quite new. He was very much interested in the more ornamental spires, and particularly in East Harling; and when it was followed up by such a splendid idea as that given in Sir Charles Nicholson's drawing, it threw a light on what had been to him a problem, until Mr. Starkie Gardner suggested that it was a leaded construction, in the Paper on the same subject read two years ago, when he (the speaker) offered some remarks.* He referred to the tower and spire of the home of the Knights Hospitallers in England, which was described by Stow as being "a great ornament to the City the like of which he had never seen: it was graven gilt and enamelled," and it had puzzled him for a long time to conjecture what the material could be. But looking at Sir Charles Nicholson's drawing it struck him that there could be no other explanation of the magnificent structure which was destroyed by the notorious Protector Somerset in order that he might use the stone for building his palace in the Strand. He did not know of any other record of a similar structure in this country .With regard to the suggested use of steel spires covered with lead, that might be very honest construction, but Heaven forbid they should ever repeat what they saw at Rouen and at Cologne, where, after the timber spire was destroyed, cast iron was used as a substitute. In Mr. Lethaby's work views were given of fonts and other things which were only conjecturally fonts, cast lead vessels with handles of which the use was not clear. Perhaps Mr. Troup might remember those illustrations and be able to tell them what they were for. When the Templars' goods were seized in the Temple in 1307, by order of the King, in the inventory of goods given up were items found in the brewery—*e.g.* "one lead, 40*s.*; one lead, 30*s.*; one lead, 10*s.*" He had never been able to make out what those articles could be. They possibly were not ingots, the valuation was too high, and odd pieces at 8*d.* each were also recorded. They might be something in the nature of a cistern or tank, because the value of money at that time was very considerable. It would be a matter of interest to know whether these were lead cisterns or tanks used for brewing purposes. There was another use of lead which had not been mentioned —viz., for insignia in interments. There was the instance of Abbot John Dygon, 1509, who had been buried with, not only leaden episcopal rings, but with a leaden paten, chalice, and mitre: these objects had been found with the remains of the skeleton when it had been unearthed centuries later. The objects were most elaborately coloured and gilt: it seemed altogether a novel way of using lead.

The CHAIRMAN, in putting the vote of thanks, said he should like to tender his personal thanks to the gentlemen who had read such very interesting Papers. The practical details Mr. Troup had given were of very great value, and the beautiful enamelled work he showed was highly interesting. An art like the latter that had almost died out he hoped might be revived, for it contained in itself a permanent decoration which would be far better than many of the enamels now used; like that, for

* Vol. XI. R.I.B.A. Journal, pp. 149, 156.

instance, in the drinking-fountain at Westminster. Mr. Weaver's Paper—which, if he might be allowed to say so, was most wittily delivered—was in itself a very poetical Paper, dealing with a very poetical subject. It was a most fascinating illustration and description of some of the fine church spires we have in England. As his Paper was confined to spires, he naturally did not refer to the many other ways in which leadwork had been used for decorative treatment. It was a moot question whether the great Nonesuch Palace had its decoration in leadwork or in plaster. Authorities differed on that point. It had been asserted that its very elaborate decoration was all in cast lead. Lead had been used in many other ornamental ways. Some of the beautiful old cisterns were quite works of art, and displayed an architectural knowledge and craftsmanship on the part of the plumber who made them which was highly commendable. With reference to the use of lead on steel there must be some disconnecting material, or galvanic action and corrosion would take place, which would create great evils. When he used lead he generally put felt in as the intermediate material; this, he thought, was a very safe non-conductor. With reference to Chesterfield, which Colonel Prendergast held to be originally designed as it now appeared, they had heard of eccentric architects, but he could not imagine that any architect could have designed Chesterfield spire as they saw it to-day. If he did, they should look upon him as rather a crazy person. It was interesting because it was so twisted, and because it stood without falling; for it was said to be something like 3 feet 6 inches out of the vertical. As Sir Charles Nicholson had suggested, it was usually attributed to the new timber in its construction which had twisted very badly, and had remained intact probably because it was thoroughly well put together, and the oak dowel and pins with which it was held together kept it from falling.

Mr. F. W. TROUP, answering some of the questions, said that with regard to tinning he would read a description given by Burges. He did not know how he (Burges) got hold of it —possibly from questioning workmen in France. M. Félibien, in his seventeenth-century book on "Plumber's Work in France," has the following description of tin as used in covering lead sheets: "When plumbers wish to tin sheets of lead they have a tinning furnace full of hot charcoal, on each side of which a man stands holding up and heating the sheets of lead. Leaves of tinfoil are laid over these, and as the sheets get hot and the tin melts the tinning is accomplished by rubbing and spreading it over the surface with tow and resin." That was very much as one would tin the inside of a saucepan. Burges's description was as follows:— "The next thing, of course, was to fix the lead in the position it was designed to occupy; for the tinning was done in the workshops, although occasionally it was performed when the lead had been up many years." That is to say, there was nothing to prevent the lead being tinned after it was fixed on the spire or roof, or wherever it was, although it is much easier to do it in the workshops. "Thus," continues Burges, "the spire of Notre Dame at Châlons-sur-Marne was probably constructed in the fourteenth century; but we must refer the tinning to at least a century later. In this case the process was the same, only much more tedious, as the workman was only able to apply so much tin as the end of his axebit would take up." That is to say, he had his axebit, which was a copper bit for melting the tin, shaped like an axe, and he rubbed it on a brick, or something of that sort, where he had the tin lying; he picked up as much tin as he could get and plastered it on the surface of the spire, only tinning quite a small piece at a time. The consequence was the tinning was quite rough on the surface when it was done *in situ* in that way. "Accordingly," says Burges, "we find the work in the instance under consideration very coarse and rough, contrasting strongly with that on the dormer window at the east end of the same church. All the leadwork of the roof was more or less susceptible of this decoration; but it was generally confined to the more ornate parts, such as the bases of the girouettes and the dormer windows, but more especially to the ridge pieces, which latter contrasted well with the long dark body of the roof, which was left plain." Burges then describes the workshop process. "The process of tinning is thus performed. The lead being first of all covered with a tolerably thick coating of lamp-black and size, and the pattern traced with a point, all that part of the surface to be tinned is removed with a shave-hook so as to leave it clean and bright; a little sweet oil is then rubbed over, and the solder applied and thinly spread with a copper bit in the usual manner." That, continued Mr. Troup, was the way it was usually done now. The lead is covered with plumber's soil, as they call it, and the parts the tin is to be applied to are cleaned out. Solder is almost as good as pure tin if good solder is used, because when the tin itself becomes amalgamated with the surface of the lead it practically becomes solder, as it absorbs a certain amount of the lead and alloys itself with it. There is another way in which it can be used ornamentally: instead of covering the lead with plumber's soil and then scratching out the shape desired to be tinned, it can be done by cutting out the ornament in paper and pasting that on to the surface of the lead after having cleaned the whole surface. The tin is then applied on the solder in the same way as before, and of course it attaches only to the parts of the lead which are exposed. That, he believed, was the way that some part of the roof of Hatfield House had been ornamented. The marks of the edges of the brown paper where the tin stopped could actually be seen.

That was the process of tinning on lead, and one could easily understand it was very much easier to do it in the workshop before the lead was fixed than to do it *in situ* after it was on the roof. There was no great difficulty about fixing lead upon another base than woodwork. Modern milled lead was usually softer than the old cast lead, which was thicker to begin with, which made it stiffer, and the result was it could be hung on to a piece of iron without the danger of its folding down in the sun and hanging down like a piece of wet cloth, as the modern thinner lead does; and they constantly supported lead simply with iron hooks or an iron framework without any protection in the way of felt or anything else. So long as there was no leakage in the lead, allowing the water to come in and get between the lead and the iron, there was no great harm, because the galvanic action did not take place when the two metals were dry. As regards the use of felt, if the water got in he was afraid the felt would not be much good. It was quite possible to make a good galvanic battery with a pile of coppers and zinc with felt between them so long as they were wet. Viollet-Le-Duc says it is almost impossible to keep the acid in fresh oak from attacking the under surface of the lead. It can be covered with paint or varnish, and even with molten resin; but the pyrogallic acid, or whatever it is, comes through almost everything and attacks the lead, such is the avidity with which the acid seems almost to seek for the lead. He did not think there was any way of getting over that difficulty except to wash it out of the oak before it was used, and so get rid of it. He should think uralite would be a very good basis for lead; it was probably unnecessary in cast lead because it was so much stiffer; it would hang on a framework instead of having to be supported all over as a modern roof is. The boarding in some of the French cathedrals was not continuous. One could see the insides of a good many of them—Beauvais was the last he saw—and the oak boards appeared to be only four inches wide, with perhaps three inches between them; the underside of the lead could be seen from the inside of the roof. That was a very common way. It was a very good thing in other ways, because it allowed the air to pass through the spaces and keep the wood more ventilated. That was quite possible with the old thick cast-sheet lead; whereas with modern lead, if it were only 7-lb. lead, or something like that, it would show on the outside; it would sag down between the supports if they were anything more than an inch apart; in fact, one very often does see the marks of the joints in the boards in ordinary leadwork, especially in gutters and places like that. With regard to ironwork as a framework for roofs, the roof of Chartres Cathedral was ironwork from end to end; it was not covered with lead, but with sheets of copper. The copper sheets were hung between ribs of iron, not steel; it was done about sixty or seventy years ago, before steel began to be used. The Rouen spire that was referred to had no lead at all; it was simply a skeleton of cast iron. It could easily be covered with lead if there were any desire to do it. With regard to lead for tanks for breweries he should think it would be rather dangerous to use lead for such purposes, because the acid in the beer would attack the lead and dissolve it, making it poisonous. The French Government have a regulation about pewter. They do not allow more than one third lead in pewter—common kinds of pewter which are used in public-houses—the rest must be tin. Beyond that proportion the acid in the beer or cheap wine begins to take effect upon the lead, and lead-poisoning ensues.

Mr. LAWRENCE WEAVER, referring to the twisted spire of Chesterfield, said he did not think anybody could possibly have perpetrated such a grotesque practical joke as to build a spire in that way; moreover, it was not at Chesterfield alone that there was a spire which was twisted badly. There was a little spire in Norfolk, at Walsingham, which was nearly as bad; but as it was not such a big spire it did not show so much. With regard to the material between the steel spire and the lead covering, he had himself thought of uralite, and believed that it would do very well. There must be plenty of materials which would answer all the purposes, and which would not burn—which was the great thing. He quite appreciated the importance of the late Eden Nesfield's work, but what he felt about Mr. Lethaby was, that he was the only person who had written a book on the subject. There were an enormous number of people who would never have known there was such a thing as artistic leadwork if it had not been for Mr. Lethaby's book—he himself should not, for one. But once pick up this little book, it was so charmingly written that it stimulated one's interest and set one making all sorts of researches. With regard to the little vessels in Mr. Lethaby's book referred to by one of the speakers, there was one vessel there which had triangular ornaments on it, and iron handles. Mr. Lethaby called it an Anglo-Saxon vessel; it was not a font, but was probably a large salt, possibly from a monastery. He had discussed the matter with the greatest living authority on fonts—Dr. Alfred Fryer—and he suggested a salt. There was a small vessel at Gloucester which had the Deposition from the Cross on its four faces: it was extremely delicately moulded, and had little bands of floral ornaments and the emblems of the Passion. It could not be a font, for it never had a cover. It was too large to be a vessel for the ablutions at Mass. He thought it might possibly be a stoup. There were twenty-seven lead fonts. With regard to the question of interments there were certainly a great number of lead patens. He did not know of the

mitre, and he was glad to know of it. Patens and chalices of lead were used often. If a paten or chalice of lead were gilded, anybody who was a long way off could not tell that it was not gold, so the mourners got the benefit of being generous without the cost. From the very earliest times when there were votive offerings in honour of the dead they had constantly been frauds. There were some very interesting things to which Mr. Hudson had not referred, viz., lead burial crosses. Nobody who had any self-respect in the middle ages was buried without a pectoral cross round his neck. Even in times of great national stress, as during the Black Death, everybody had a cross, and they were often made of lead. When they were digging on the site of Christ's Hospital recently Mr. Hilton Price, the Director of the Society of Antiquaries, came upon a most extravagant find of lead crosses. There were scores of them, none of them in the least bit decorated—very plain, rough pieces of lead just chiselled out of the sheet, evidently made in a great hurry, as people were dying rapidly. Finally, with regard to what had been done in leadwork and what had been written upon it, he thought that, after all, Burges must have the earliest credit, for he was earlier than Mr. Lethaby, and earlier even than Eden Nesfield.

Sir CHARLES NICHOLSON, writing since the Meeting, says:—

The following fact escaped my memory at the time of the meeting, but it has since occurred to me that it may be of interest in connection with Colonel Prendergast's remark about Westminster Hall roof. In one of the volumes of the *Gentleman's Magazine* about the beginning of last century there occurs a strongly-worded protest, probably written by John Carter, the well-known antiquary, against the removal of the old lead from the roof of Westminster Hall, and the substitution of slates. From this it would appear that this vandalism was committed about the time when the old Law Courts were built by Sir John Soane, though it cannot be said for certain that he was the culprit, since one of the Wyatts was also employed upon the Palace of Westminster about this period. Probably the dormers were inserted in the old roof at the same time that the slates were put on.

It should be remembered, in justice to Soane and his contemporaries, that in their day the Hall was more or less masked by buildings on both sides, so that the ugliness of its big slated roof was less apparent than it is now that the old buildings on the west side of the Hall have been replaced by the comparatively low annexes designed by the late J. L. Pearson.

9, Conduit Street, London, W., *24th March* 1906.

CHRONICLE.

Prizes and Studentships 1907.

The pamphlet giving full particulars of the Prizes and Studentships in the gift of the Institute for the year 1907 is issued to members with the present number of the Journal, and is on sale at the Institute, price 3*d*. The total value of the Prizes, exclusive of Medals, amounts to £494 5*s*. The prizes and subjects are briefly as follows:—

The Essay Medal and Twenty-five Guineas, open to British subjects under the age of forty.—*Subject:* "The Influence of the Use of Iron and Steel on Modern Architectural Design."

The Measured Drawings Medal and Ten Guineas, open to British subjects under the age of thirty.—Awarded for the best set of measured drawings of any important building—Classical or Mediæval—in the United Kingdom or Abroad.

The Soane Medallion and One Hundred Pounds, open to British subjects under the age of thirty.—*Subject:* Design for a large City Hotel facing a Public Square.

The Pugin Studentship: Silver Medal and Forty Pounds, open to members of the architectural profession (of all countries) between the ages of eighteen and twenty-five.—Founded to promote the study of the Mediæval Architecture of Great Britain and Ireland, and awarded for the best selection of drawings and testimonials.

The Godwin Bursary: Silver Medal and Sixty-five Pounds, open to members of the architectural profession without limitation of age.—Founded to promote the study of works of Modern Architecture abroad, and awarded for the best selection of practical working drawings, or other evidence of special practical knowledge, and testimonials.

The Owen Jones Studentship: Certificate and One Hundred Pounds, open to members of the architectural profession under the age of thirty-five.—Founded to encourage the study of Architecture more particularly in respect to Ornament and Coloured Decoration. Competitors must submit testimonials, with drawings exhibit-

ing their acquaintance with colour decoration and with the leading subjects treated of in Owen Jones's *Grammar of Ornament*.

THE TITE PRIZE: CERTIFICATE AND THIRTY POUNDS, open to members of the architectural profession under the age of thirty.—*Subject:* A Design, according to the Principles of Palladio, Vignola, Wren, or Chambers, for a Loggia for Sculpture to screen the blank end, 150 feet long, of a building.

THE GRISSELL GOLD MEDAL AND TEN GUINEAS, open to British subjects who have not been in practice more than ten years.—Founded to encourage the study of Construction. *Subject:* Design for a Grand Stand constructed of timber on a Racecourse, to accommodate 1,000 people in the boxes and 3,000 on the roof.

THE ARTHUR CATES PRIZE: A SUM OF FORTY GUINEAS, open to British Subjects who have passed the R.I.B.A. Final Examination at one sitting during 1905 and 1906.—Awarded for the best set of testimonies of study submitted for the Final Examination, and for studies of Classical or Renaissance, and of Mediæval Architecture.

THE HENRY SAXON SNELL PRIZE: A SUM OF SIXTY POUNDS, open to any member of the architectural profession (who may associate with him any member of the medical profession).—Founded to encourage Study of Improved Design and Construction of Hospitals, Convalescent Homes, and Asylums for Aged and Infirm Poor. *Subject:* A Critical Report on Hospitals for the Treatment of Consumption.

THE ASHPITEL PRIZE: BOOKS VALUE TEN POUNDS.—Awarded to the student who distinguishes himself most highly in the Institute Final Examinations 1906.

Joint Committee on Reinforced Concrete.

At the instance of the Science Standing Committee a Joint Committee has been formed of members of the Institute and other bodies interested, to draw up rules for the guidance of architects in the use of Reinforced Concrete. The Committee, which is presided over by Sir Henry Tanner, is made up as follows:—

Representatives of the R.I.B.A.: Messrs. T. Walmisley, William Dunn, Max. Clarke, H. D. Searles Wood.

District Surveyors' Association: Messrs. Thomas Henry Watson and E. Dru Drury.

Institute of Builders: Messrs. Benjamin I. Greenwood and Frank May.

Incorporated Association of Municipal and County Engineers: Messrs. A. E. Collins and W. Cockrill.

War Office: Colonel C. B. Mayne and Major E. M. Paul, R.E.

Other members: Professor W. C. Unwin and Mr. Charles F. Marsh.

The Further Strand Improvement Scheme.

At the Meeting last Monday, before the regular business was proceeded with, Mr. Maurice B. Adams [*F.*] asked if the Chairman would explain why the Institute was not represented on the Strand Further Improvement Memorial, which had been sent that afternoon to the London County Council. The Institute had taken a very prominent position with regard to the matter, and he noticed that almost every other Society was mentioned, but the Institute was not.—The Chairman (Mr. Edwin T. Hall, *Vice-President*), in reply, stated that the Institute Council had decided not to take part in the particular movement to which Mr. Adams referred because they had already made their own representations to the County Council, and had only quite recently been in communication with them, urging views in the same direction as that recommended by the Institute about a year ago.

The meeting referred to by Mr. Maurice B. Adams was held at the Royal Academy on Monday afternoon, the 19th inst., Sir Edward Poynter, P.R.A., in the Chair, its object being to consider the Memorial to the London County Council in favour of the scheme of the Further Strand Improvement Committee. Among members of the Institute present were Lord Plymouth [*H.A.*], Sir Wm. Richmond, R.A. [*H.A.*], Sir Aston Webb, R.A. [*F.*], Mr. T. W. Cutler [*F.*], Mr. Maurice B. Adams [*F.*], and Mr. Mark Judge [*A.*], Secretary of the Further Strand Improvement Committee. The Memorial stated that the Gladstone monument, now erected at its allotted point, intensifies the need of the alteration for which appeal is made. The monument is so placed that it makes the eastern end of the site between Aldwych and the Strand still more awkward to eastward traffic. The Memorial proceeded: "To state concisely our objection to the plan adopted, it is that, between the two churches, the north side of the Strand, instead of being planned so as to give the roadway its natural course direct to the Courts of Justice, deviates some 60 feet towards the south, thus forming a barrier between the portions of the Strand east and west thereof. Our reasons are that (i.) we consider the plan is in itself an ugly, distorted figure; (ii.) when buildings are erected on the site, these will obliterate from the west the view of the Courts of Justice and the church of St. Clement Danes, and from the east that of the church of St. Mary-le-Strand; (iii.) being at an angle encroaching upon the church of St. Mary-le-Strand, the buildings will mar the beautiful aspect of that church from wheresoever viewed; (iv.) the angles of the roadway are awkward and dangerous to traffic. We submit, therefore, that the matter should be considered from the point of view, not only of what is for the moment financially desirable, but also of what is befitting the dignity of the capital of our Empire." The memorialists

further contended that the alteration is essential, and, moreover, would materially enhance the value of the frontage, thus to some extent compensating for the reduction of building area. The memorial concluded :—" As pointed out in the report of the Royal Commission on London Traffic, Paris, New York, Washington, Berlin, Brussels, Vienna, have streets finer than any that London can show. We ask, Is London, by want of determination to overcome minor difficulties, to refuse this opportunity of showing itself in reality an Imperial city, a worthy capital of a world-wide Empire? We are unwilling to think so, and trust you will seriously reconsider the plan as at present adopted, and grant our appeal."

Sir Edward Poynter and Mr. Mark Judge having addressed the meeting,

Lord Plymouth moved the following resolution: "That, in the opinion of this meeting, the Memorial of the Further Strand Improvement Committee, the Royal Academy of Arts, and other corporate bodies makes a clear case against the plan adopted for the building land between Aldwych and the Strand, and that the London County Council be requested to receive a deputation charged with the duty of presenting the Memorial." He was convinced, he said, of the importance of the London County Council's reconsidering the Strand improvement scheme. This scheme for the improvement of London was larger, he believed, than any that had been undertaken since the Great Fire in 1666. We were now laying down the line of our east-to-west thoroughfare, with which untold millions of people in the many years to come would become familiar, and they would hold the present generation responsible if the Strand had a blot upon it which for centuries at least might impair its dignity and architectural effect. No practical body of men could disregard the question of expense, and those who had signed the Memorial did not desire for one moment to ignore it. But they wished that it should be weighed carefully with other considerations. It was surely a short-sighted policy, in order to secure some immediate advantages to the present ratepayers, to shut their eyes to great subsequent advantages, and even pecuniary advantages, that would accrue if the lines of the thoroughfares and buildings were laid out on a dignified scale.

Mr. Harold Cox, M.P., seconded the motion.

Mr. Frederic Harrison, who was Chairman of the Improvements Committee of the Council when the original scheme of the Strand improvement was planned, supported the resolution.

Sir Aston Webb, R.A., said that the Royal Institute of British Architects felt very strongly that a great mistake would be committed if some alteration were not made in the alignment proposed. All his brother architects felt, as he did, that they could not appeal too strongly to the London County Council to make some alteration in the line, and give London a magnificent thoroughfare from Charing Cross to St. Paul's Cathedral.

Sir William Richmond, R.A., remarked that if they succeeded in persuading the County Council that it was dealing with a matter which belonged to generations to come, and was not a matter of a decade or two, they would do much to induce that body to appoint a small but thoroughly representative art standing committee through whose hands all metropolitan schemes must pass.

The resolution was adopted unanimously.

The London County Council, at their meeting the following day, Tuesday, 20th inst., adopted a recommendation of their Improvements Committee to lease the central portion of the crescent site to a syndicate for ninety-nine years at a ground rent of £55,000 a year. Sir Melvill Beachcroft asked the Council to add the following words to the recommendation: "And that the building line at the south-east end be such as the Council may determine, having regard to the alignment which the Council may fix hereafter." This was ruled out of order, it being stated that the matter would have to be dealt with as a separate proposal. Mr. Allen, M.P., at the same meeting presented a petition from Sir E. Poynter and a large number of influential persons praying that the alignment of the Strand near Aldwych might be so revised as to preserve an uninterrupted view of the Law Courts.

The Chairman of the London County Council, in a letter to Mr. Mark Judge on the 20th March, says: "You may depend that the very important resolution passed by such a distinguished body—the members of the Royal Academy—will receive the very earnest attention of the Improvements Committee who have the matter in hand."

Aldwych Building Scheme.

The following particulars are given of the buildings proposed to be erected on the central portion of the island site in the Strand by Aldwych:—It is proposed to erect on the central portion of the site a stone building of commanding architectural features. This building will contain large galleries for use in a permanent exhibition of arts and manufactures; it will also contain a theatre, a concert hall, and a restaurant. Beyond the central block of buildings the site will be enclosed by shops with basements, ground floors, and two floors above. There will be seventy-eight shops on the ground floor and seventy-eight on the first floor, while the second floor will be let for commercial purposes. The promoters have undertaken to spend not less than £500,000 in the erection of these buildings. They state that negotiations have already been begun for letting portions of the buildings, and that they have no doubt as to the disposal of the whole to substantial tenants. There will be no larger area between the shops and

the central building than that which is necessary to provide for the access of light and air. The plans, elevations, and specifications of all the buildings will be entirely subject to the Council's approval. The lease will be in the Council's usual form, subject to such modifications as may be necessary for the special undertaking, and will give the Council entire control as to the uses to which the buildings will be put, and also the right of re-entry if the buildings are put to any other use than that sanctioned when the lease is taken up.

Royal Sanitary Institute Congress.

The Twenty-third Annual Congress of the Royal Sanitary Institute is to be held at Bristol, from the 9th to the 14th July, under the Presidency of the Right Hon. Sir Edward Fry. Messrs. Edwin T. Hall [*F.*] and G. H. Oatley [*F.*] (of Bristol) have been appointed by the Council to represent the Institute. Mr. Edwin T. Hall will act as President of Section II. Engineering and Architecture.

The late William Gibbs Bartleet [*F.*].

Mr. W. G. Bartleet, whose death occurred on the 10th inst., was one of the oldest members of the Institute, having joined as an Associate in 1858 and been elected Fellow in 1869. Mr. Bartleet was born in 1829 at Handsworth, near Birmingham, and was educated there. His father however subsequently settling in London, he was articled to the late John Walker, of 69 Aldermanbury and Gresham Street, City. At the expiration of his articles in 1850, he spent some years in an architect's office in Chichester, and afterwards returned to London and set up on his own account in Pinner's Hall, Old Broad Street. He soon laid the foundations of what eventually grew into an extensive general practice in London and surrounding counties, erecting a large number of business premises, residential flats, factories, warehouses, banks, and many country houses, chiefly in Essex, Kent, and Surrey. He was also responsible for several new churches and restorations. Among his chief commissions may be mentioned Holfield Grange, Essex; Woodlands and Grange Hill, Chigwell Row; Presdales, Ware; Hill House, Upminster; Long's Hotel, Bond Street; Bush Hotel, Shepherd's Bush; Vicarage, Brentwood; Shenfield Schools. He carried out alterations and extensive additions to Blackdown House, Haslemere, an old sixteenth century mansion. He was chosen as architect for the rebuilding of St. George's Church, Beckenham, the tower of which was only completed about eighteen months ago, twenty years after the church building operations were commenced. He held several surveyorships at different periods of his practice, including that of the Metropolitan Dispensary, Fore Street, and the Pollen and other trust estates, and was also assessor to the Southwark County Court. He erected many country branches for the London and County Bank and depots for the Aërated Bread Company. He was for many years treasurer for the Beckenham Cottage Hospital. The new wards and also the children's ward in memory of Queen Victoria's Jubilee were built under his direction. His son, Mr. Sydney F. Bartleet, himself a Fellow of the Institute, had been in partnership with him during the last fifteen years. On the occasion of the funeral, which took place at Shirley Churchyard, a wreath was sent from the Institute as a mark of sympathy with the relatives in their bereavement.

Architects' Benevolent Society.

The Annual General Meeting of the Society was held on 9th March, Mr. J. Macvicar Anderson presiding, in the absence, through illness, of the President, Mr. John Belcher, A.R.A. The Annual Report was adopted as follows:—

The Council in presenting the Fifty-fifth Annual Report of the Architects' Benevolent Society have to express regret that, judging by the number of claims made upon the Society, the past year seems to have been one of exceptional difficulty for many of the less fortunate members of the architectural profession. Towards the middle of the year it was found that the demands made upon the Society were beginning to outweigh the funds at the disposal of the Council, and that it was necessary to consider means by which the income could be increased. The President (Mr. John Belcher) acceded to a suggestion that he should issue a personal letter of appeal, and this was sent out to 5,280 architects practising in the three kingdoms. The President directed attention to the fact that, although this Society had been in existence for over fifty years, and was the only institution organised specially for the relief of architects or their widows and orphans, not more than 1 per cent. of architects in active practice contributed to its support. As the income had suffered in recent years from the loss of many liberal contributors, the President appealed particularly for subscriptions. Compared with the support hitherto accorded, the result of the appeal must be considered satisfactory, the subscriptions having been increased some 20 per cent., while a considerable sum has been added to the capital. The grateful thanks of the Society are due to the President for the active interest which he has taken in this matter, and it is hoped that the effect of his letter is not yet exhausted.

In connection with the appeal, the Council wish specially to call attention to an offer of a donation of £50 by Mr. Walter Emden if nine other contributions of an equal amount are received. Mr. Emden's offer has so far been supported by Mr. William Glover, Mr. H. Chatfeild Clarke, and the Society of Architects.

In answer to many suggestions received during the year, by which the objects of the Society might be made more widely known, the Council desire to point out that over two thousand Red Books are distributed annually, and that advertisements appear from time to time in the professional journals. The result, however, is not sufficiently encouraging, in the Council's opinion, to justify further expenditure in this direction. The greatest benefits accrue to the Society from the personal interest and influence of its members. Too much emphasis cannot be laid upon the fact that where circulars and advertisements fail, the individual propagation of the aims and needs of the Society succeeds.

The total amount of subscriptions received during the year was £615. 19*s*. 6*d*. (last year £539. 5*s*.); the donations amounted to £765. 17*s*. (last year £143. 1*s*.). The Society's investments were increased by the purchase of £600 New Zealand Three per Cent. inscribed Stock at a cost of £531. 16*s*. To meet the claims of applicants, it was found necessary to transfer £140 received in response to the President's appeal (which was made especially to relieve current needs) from Capital to Income Account.

The amount of £1,000. 3*s*. was distributed in grants and pensions. The number of applicants, apart from pensioners, was eighty-six, out of which eighty were granted assistance.

Through the courtesy of Mr. John Holden, the Society's honorary local secretary at Manchester, the Council have been informed that Mr. Alexander W. Mills, of Bowdon, Cheshire, an old subscriber, has bequeathed to the Society £500. Further bequests of £21 from the late Mr. C. Forster Hayward, and two Architectural Union Company's shares from the late Mr. H. H. Collins, have also been received.

It is with great regret that the Council have to record the death of these members (Mr. Collins was also a member of the Council at the time of his death), as well as of Mr. Alfred Waterhouse, Mr. J. T. Wimperis, and Mr. G. Fowler Jones, all old subscribers.

The Council desire to express their appreciation of the kindness of the committee of the A.A. Students' Smoking Concert in devoting part of the proceeds of the concert on 2nd February to the funds of the Society, the amount received being £12. 12*s*.

To meet the wishes of corporate bodies, a Resolution will be submitted by which such bodies may be represented, subject to the fulfilment of certain conditions, on the Council and at general meetings by their Presidents for the time being, and granted the same privileges with regard to the recommendation of applicants for relief as possessed by individual members.

Seven meetings of the Council have been held during the year.

Owing to the absence of Mr. Graham C. Awdry from London, Mr. Edward Greenop kindly undertook the auditing of the accounts with Mr. Sydney Perks.

Mr. S. D. Kitson, M.A., has consented to act as Honorary Local Secretary at Leeds.

The following gentlemen, being the five senior members, retire by rotation from the Council: Mr. Edwin T. Hall, Mr. Lewis Solomon, Mr. Wm. Woodward, Mr. H. H. Collins (deceased), and Mr. T. E. Collcutt. To fill the vacancies caused by these retirements, the Council have the pleasure to nominate: Mr. Arthur Ashbridge, Mr. Walter Emden, Mr. Reginald St. A. Roumieu, Mr. H. Chatfeild Clarke, and Mr. Alfred Saxon Snell.

The thanks of the Society are due to the Royal Institute of British Architects for office accommodation, and for the use of rooms in which to hold their meetings, and to the Secretary (Mr. Locke) and his staff for their helpful courtesy in all matters connected with the Society.

Thanks are also due to the editors of the professional journals for the space which they have granted to the Society's proceedings and for sympathetic references to its work and objects.

The Chairman, in the course of some remarks at the meeting, said he hoped that the offers made to give certain sums of money in aid of the Society's efforts, provided that other contributors could be induced to give the same amount, would not be forgotten. What had once been done could be done again, if members put themselves to a little personal sacrifice.

The following is the Council for the ensuing year of office:—President, the President of the Institute; Vice-President, Mr. Wm. Glover; Council, Mr. Rowland Plumbe, Mr. G. T. Hine, Mr. Ambrose M. Poynter, Mr. Wm. Grellier, Col. R. W. Edis, Mr. H. L. Florence, Mr. G. B. Bulmer, Mr. F. W. Hunt, Mr. W. L. Spiers, Mr. Arthur Ashbridge, Mr. Reginald Roumieu, Mr. Walter Emden, Mr. H. Chatfeild Clarke, and Mr. Alfred Saxon Snell.

The Temple of Onias.

The Times of the 14th inst. has the following notes from a correspondent on the excavations undertaken this winter by the British School of Archæology in Egypt on the eastern side of the Delta and in the region of Goshen and Succoth:—

Among the problems there one of the most interesting was the search for the site of the Temple of Onias. It is well known how the troubles of the Jews under Antiochus had driven many of them to settle in the east of the Delta, and that, in order to provide a new rallying-point, one of the family of the high priests, Oniah IV., had built a temple on the model of that at Jerusalem. This temple served as a substitute for the shrine desecrated and polluted by Antiochus Epiphanes. The documents quoted by Josephus show that this temple was at the site of an old Egyptian town named Leontopolis, which was dedicated

to the lion-headed goddess "Bubastis of the Fields," that the place was "full of materials," that the temple was built after the pattern of that at Jerusalem, that "a tower of stone 60 cubits high" was erected, and that the whole settlement was granted by Ptolemy Philometor. Thus there were many conditions to be fulfilled in the identification of this site.

It has been generally recognised that the ancient town known as Tell el Yehudiyeh, eighteen miles north of Cairo, was probably the position, and the Jewish grave-stones found there by Dr. Naville had given strength to this opinion. But the temple had not yet been actually identified. The work of this season has in the first place shown that a lion-headed goddess was worshipped there, as a statue of an admiral of the Mediterranean fleet of Psametek II. was found, which represents him holding a shrine of the lion-headed goddess. Hence the name of Leontopolis and the dedication to "Bubastis of the Fields" accord with the worship at this site. The description of the place as being "full of materials" for re-use by Onias agrees with there having been an immense stone-lined ditch a mile in length around the ancient town, which would supply material for the new building without using what had been consecrated to idols. Just outside of the ancient town stands an artificial mound, the highest for twenty or thirty miles around. The whole of it has been thrown up at one time; and, on restoring the buildings on it by the remaining indications, it is found that the height must have been altogether over 59 Greek cubits above the plain, agreeing with the 60 cubits of construction named by Josephus. And this mound was thrown up in the second century B.C., as is shown by the pottery in it. On the top were many coins of the time of Ptolemy Philometor, and a sherd with building accounts which bears the name of Abram among others, showing that Jews were employed. . . .

The form of this settlement of Onias was, roughly, a right-angled triangle, the square corner being formed by the north and east sides. At the west acute angle was the entry to it, and at the south point was the summit with the temple. The mound was enclosed on the eastern side by a stone wall, 20 feet or more in height, and 767 feet long, including two bastions at the ends. In the middle of this a high raised stairway, 14 feet wide, led up to the entry of the temple court on the top. The north side of the settlement was low, with a fortification wall bounding it. The diagonal west side was curved inward, and had a great revetment wall, at least 20 feet thick, rising at an angle of 66° or more to a height of over 68 feet, where it supported the temple.

The entrance from the plain at the west end was nearly 150 feet wide over all, and about 100 feet inside. This was fortified with towers and gateways, as we know from descriptions. From here the way ran through an area of three or four acres of houses enclosed in the fortifications leading up to the temple platform more than 68 feet over the plain. The foundation of this ascent remains, and points very closely to the axis of the court on the top. The outer court was 32 feet wide and 45 feet long inside; the inner court was 24 feet wide and 64 feet long. The block of the brick foundation of the Holy of Holies is 55 feet long and 17 feet wide. This is of the same proportion as in Solomon's temple, namely, seven to two; and it shows that the building was laid out with half the number of cubits of the prototype, and by the Greek cubit, which was probably the most familiar to the Jews under the Ptolemies. The architecture was Corinthian, and the front of the courts, or of the temple, had the usual Syrian decoration of rounded battlements. The fronts of these battlements were ornamented with a band of lines which rose from the string-course into each block and returned.

The religious character of the whole place is marked by the great quantity of sacrifices at its foundation. In the lower part of the mound are found on all sides cylinders of pottery a couple of feet across. These were sunk in the ground, a fire sacrifice was burnt in each, and then the fresh earth was thrown in to smother the fire, in continuation of the heaping of the mound. This is at one with the Syrian sacrifice under a building, and the later form of that known as "lamp and jar burial," familiar from Mr. Macalister's work in Palestine.

Most unhappily, the ravages of the natives digging for earth have barely left the outline of the foundations of the temple; but twenty years ago the walls were standing, and the pavement and pillars were seen here. . . . Such a loss of an historical building, owing to not recording the remains before their destruction, is an object-lesson in the need of thorough research in Egypt. The work will not wait, and every help given to present labours saves what will soon be irrecoverable. Contributions for this purpose should be sent to the Secretary of the "British School in Egypt" at University College, London.

The other work of the British School, beside Professor Flinders Petrie's researches described above, includes his excavation of a Hyksos cemetery and a great fortress of a new type, and his discovery of remains of a temple of Rameses II. in the region of Succoth. The Rev. J. G. Duncan's work has opened a cemetery at Tell Yehud containing burials of the second century A.D., under Syrian or Jewish influence; also he has examined a fortified town of Ramesside age near Belbeys which contains large granaries. He and Mr. C. Gilbart-Smith are at present at Saft, the ancient Goshen, where a cemetery of the eighteenth dynasty has now been discovered. Mrs. Flinders Petrie and Mr. T. Butler-Stoney have prepared drawings of all the objects found in those sites.

MINUTES. X.

At the Tenth General Meeting (Ordinary) of the Session 1905-06, held Monday, 19th March 1906, at 8 p.m.—Present, Mr. Edwin T. Hall, *Vice-President*, in the Chair, 28 Fellows (including 9 members of the Council), 25 Associates (including 2 members of the Council), 1 Hon. Associate, and several visitors: the Minutes of the Meetings held Monday, 5th March 1906 [*ante* pp. 255, 256], were taken as read and signed as correct.

The Chairman referred with regret to the continued indisposition of the President, which prevented his attendance at the Meeting.

The following members attending for the first time since their election were formally admitted by the Chairman—viz. Matthew Garbutt, *Fellow*; Sydney Bridges, Ernest Llewellyn Hampshire, Henry Alfred Moon, *Associates*.

The Hon. Secretary announced the decease of William Gibbs Bartleet, elected *Associate* 1858, *Fellow* 1869, and stated that on the occasion of the funeral a wreath had been sent on behalf of the Institute in sympathy with the relatives of the deceased.

In reply to Mr. Maurice B. Adams [*F.*] the Chairman stated that the Council had considered it unadvisable to take part officially in the meeting at the Royal Academy in connection with the Further Strand Improvement Scheme, a communication from the Council setting forth the views of the Institute having been recently laid before the London County Council.

Papers on LEADWORK by Messrs. F. W. Troup [*F.*] and Lawrence Weaver, F.S.A., having been read, and illustrated by lantern slides, a discussion ensued, and a vote of thanks was passed to the authors by acclamation.

The proceedings then closed, and the Meeting separated at 9.50 p.m

THE TEACHING OF MATHEMATICS TO BUILDING-TRADE STUDENTS.

By Harold Busbridge [*A.*], A.R.C.S.

Read before the Association of Teachers in Technical Institutes, 17th February 1906.

SINCE it has fallen to my lot to live in close contact with workers in the building trades from my schooldays upwards, an opportunity has been afforded me of becoming acquainted with their habits of thought and methods of work. This has enabled me the better to realise their special requirements. It therefore occurred to me that a few words might be said which would bring before teachers of mathematics the special needs and special difficulties of building men, so that those who have to teach the subject might, by getting more fully into sympathy with their students, be more successful in their endeavours to impart useful instruction.

And here may the remark be permitted that the longer one lives, the more one is impressed with the conviction that the art of teaching is mainly the art of putting oneself in the pupil's place, so as to enter fully into his difficulties, his methods of thought, his daily requirements, his surroundings, his aspirations, and his aims. I fully admit that, as a rule, those engaged in the building industries are far behindhand in their knowledge of practical mathematics. I also consider that more attention should be given to that branch of the technical training of our artisans. I venture to think, however, that the fact is often lost sight of by those who advocate one uniform course of practical mathematics for all workmen, that there is a very important artistic side to the training of our building men which has no parallel in the case of engineers. For instance, an architect's assistant must not only be well up in construction, but must be able to produce an artistic design, which involves years of patient study of art subjects. Similarly a thoroughly competent master-mason or master-carpenter should know something of the artistic treatment of stone or wood, as the case may be; and a plasterer having no acquaintance with modelling can hardly claim to be a competent tradesman.

It appears, therefore, that to produce a good all-round workman in almost any branch of the building trade the training should not be wholly scientific, but should be one in which art takes a prominent place. This, I feel convinced, is one reason why building men do not give more time to mathematical subjects. Another reason may be found in the fact that mathematics have a much more restricted application in building than in engineering work. Whole classes of problems with which the engineer has to deal almost daily are practically unknown to builders. Thus problems in thermodynamics, in motion, mechanism, and in electrical subjects would be included in this category.

In selecting the title of this Paper it may be presumed, I take it, that the Secretary of this Association had in mind the class of student for whom our polytechnics and technical institutes have been provided. This, of course, at once excludes boys still at school; and there remain those, varying in age from, say, 15 to 40 and upwards, who are learning, or who have learnt, some trade or profession connected with our building industries.

This classification will also naturally exclude most of the future leading architects, surveyors, and large builders, the majority of whom receive a higher technical college or university training in addition to premium pupilage, and, in some cases, a year or two of foreign travel.

We have left, then, the subordinates on the staffs of the principals just referred to, together with the rank and file of workers included in the various skilled trades, whose members in varying numbers find their way into our evening classes. Of these many will need little more mathematics than will enable them to reckon up the amount of their week's wages, nor do they wish to acquire more. Others, in very rare and exceptional cases, will be able to make use of all the mathematics they can get. And here may I suggest that students such as the latter (probably of the constructional engineer type, or of the expert land surveyor order) can best obtain the instruction they need in the regular mathematical classes of our polytechnics and institutes.

In the present Paper, as a rough working basis, it will be assumed that only those trades which would be represented upon the permanent staff of a large builder may be legitimately regarded as building trades proper; and it is to the men in these trades more especially, I take it, that the special mathematical instruction of the present Paper is intended to apply.

Our list of trades will therefore include:— 1. Architects' and Surveyors' Assistants and Draughtsmen. 2. Clerks of Works, Building Inspectors, &c. 3. Foremen (Bookkeepers, Clerks, &c.). 4. Excavators. 5. Bricklayers. 6. Masons. 7. Carpenters and Joiners. 8. Slaters and Tilers. 9. Plumbers. 10. Glaziers. 11. Plasterers. 12. Painters and Decorators.

Work done by other trades, such as electric light and bell fitters, hydraulic, heating and ventilating engineers, being now largely let as separate contracts, and carried out by separate firms, employing their own specially trained staff of men, these students may be fairly left to be dealt with by the special classes organised for the

benefit of such. At all events, the mathematics required by, for instance, an electrician are of a totally different order from those required by most of the ordinary building tradesmen.

So much is this the case that the presence of any considerable number of these men in a class of ordinary building operatives would greatly increase the difficulties of a teacher in selecting concrete examples and illustrations of the work in hand in such a way as to interest and hold the attention of all sections of his class. In fact, it appears to me that the requirements of the special trades just alluded to would generally be far better met by special classes in practical mathematics for engineers rather than for builders.

Returning now to our list of trades for whom specialised mathematical training is desired, we may, I think, in considering the direction our efforts should take, at once dismiss from our minds the special requirements of excavators, slaters, glaziers, plasterers, and painters, since any scheme of mathematics suited to the requirements of the other more highly skilled trades would be equally suited to the needs of these men. We are now left with the draughtsmen &c., clerks of works &c., bricklayers, masons, carpenters, joiners, and plumbers. And with these it is not difficult to deal. Their requirements are practically identical. They may be summed up in the three words—arithmetic, algebra, and geometry—and the chiefest of these is geometry. It simply remains to trace the extent to which each of these branches should be followed, and the method of treatment which is likely to be most beneficial to those concerned. Perhaps a few words may be permitted under each of the three headings.

I. *Arithmetic.*

Of course the four rules should be mastered and a certain amount of proficiency attained in dealing with vulgar and decimal fractions. Besides familiarity with the ordinary operations involved in money sums, some little extra attention should be given to the weights and measures employed in dealing with building materials and with land. This is especially important to those who intend to take up quantities, and incidentally to all building men, who will probably, sooner or later, have to measure up building work for themselves. A few lessons upon the duodecimal system of squaring dimensions will also prove of great practical utility to all our students. This system is rarely taught in our schools, although in office work scarcely any other method is ever employed. It is with pleasure that one notes in recent years a marked improvement in those one meets in evening classes compared with the average evening student of twenty years ago. The younger men certainly seem to be better grounded in elementary arithmetic, and, speaking generally, are better prepared than they used to be to take the applied mathematics required in their several trades. Of course one meets with a large proportion of students who cannot perform the simplest arithmetical operations without making mistakes; but this I attribute chiefly to long disuse, and a little regular application will soon overcome the difficulty. Many men, too, without trying to discover short cuts, employ clumsy and laborious methods to attain results which might be arrived at more easily in less than half the time. It is also noteworthy that at first very few of our men appreciate the importance of discarding figures which have no significance. They will give an answer to eight or nine decimal places where two decimal places would more than suffice for all practical purposes. When this is pointed out to them, however, they soon learn to drop the useless figures. Of course the teacher should explain the usual methods of contracted multiplication and division, which will bring home to the student the absurdity of retaining useless figures in his results. I think it very important also that the student should be shown useful methods of rough-checking his work, so that he may gain self-reliance and be prevented from putting down ridiculously wrong answers.

As far as building-trade students are concerned, I think that logarithmic methods of calculation are altogether superfluous and unnecessary. In 999 cases out of a thousand all the calculations that a man is ever likely to have to make can be performed more directly and more easily by the ordinary arithmetical methods. I am convinced that for the vast majority of students we get in our evening classes the time spent in teaching logarithms would be far better spent if devoted to the more thorough teaching of mensuration or some more practical branch of mathematics. Indeed, it is but very seldom that even an architect or surveyor requires to use logarithmic tables. Partly for this reason I think that the Board of Education syllabus in practical mathematics is quite unsuited to the needs of our building men. It may be admirably adapted to the requirements of engineers and electricians; but as far as building men are concerned the Board of Education syllabus is practically a dead letter.

Although not in favour of teaching logarithmic methods of calculation, I am a great advocate of the slide rule. In a short lesson of about one hour's duration sufficient of the theory of logarithms could be explained to enable a student to understand and make intelligent use of a slide rule. No effort should be spared to induce every student to get one for himself, and to practise the use of it until he comes to like it. And when once he becomes familiar with it he will not willingly be without it when calculations are in hand. Probably the people who are likely to derive the greatest benefit from the use of a slide rule are draughtsmen in designing ironwork. Surveyors' assistants also, in taking rough quantities or in checking accurately squared dimensions, would effect a great saving of time and labour by

a judicious use of the slide rule. Foremen and others who have to estimate weights and quantities of materials or to check invoices might also find a slide rule a very profitable investment.

II. *Algebra.*

Algebra is of less importance to us than arithmetic or geometry. The elements of algebra, however, should be mastered by all our building students, although the examples given should be of the simplest kind. The beginner should not be frightened by a dread array of symbols leading to long and tedious operations. The object of the teacher should be to pass rapidly over the preliminary rules of addition, subtraction, multiplication, and division, and to arrive as quickly as may be at the solution of simple equations. I would not too eagerly push forward to quadratics and simultaneous equations, seeing that in building practice they are not of frequent occurrence, but would rather make sure that the pupil is perfectly competent to deal satisfactorily with any simple equation involving fractional quantities. He should be taught to regard an equation simply as a kind of shorthand statement of all the conditions involved in any given problem. From his very first introduction to the subject, he should be shown that in actual calculations the symbols stand for definite concrete quantities, and ample illustrations can be drawn from mensuration and from formulæ used in practice for the strength of beams, struts, &c.

And here I would remark that most beginners find considerable assistance in their efforts to grasp the new ideas associated with the use of letters to represent numbers if some rough system of alliteration be adopted. Thus in giving a formula for the area of a rectangle, taking A for area, b for breadth, and l for length, we may say $A = b \times l$; or in an approximate formula for the strength of a fir beam of breadth b, depth d, and span S (feet), W being the safe uniformly distributed load in cwts., we may say $W = \frac{b \times d^2}{S}$. Also, for outside and inside dimensions, capitals and italics may be employed; thus of a hollow rectangle the external dimensions may be B and L, its inside dimensions being b and l.

Many other illustrations will suggest themselves, and I have always found that the confidence and interest of a class are best gained by selecting one's examples from work with which the majority of the men are familiar, or from things of common knowledge in everyday life, the preference being always given to a definite example which has actually occurred, or which may occur in practice, instead of one which is practically improbable or impossible. Again, a man may be helped to grasp the abstractions of algebra sometimes by interpreting a formula as a verbal rule.

In dealing with men in the higher stages of technical subjects, I have often noticed the difficulty which some students experience in solving an equation, although they may perfectly grasp its significance. Simple transpositions and inversions seem to mystify them considerably, and one sometimes has to explain by means of several little steps what should be easily done mentally in one line. For this reason I think that considerable practice should be given in the solution of simple equations, and the student should be trained to express straightforward problems in algebraical language without being unduly puzzled by catch questions of doubtful utility.

Mensuration may be regarded as a branch of applied arithmetic, and although aware that this science is based upon a knowledge of geometry, I prefer to deal with it here, since the practice of mensuration is more closely associated with arithmetic and algebra than with the practical geometry which is of such great importance to builders. I suppose there is hardly another class of craftsmen in the country to whom mensuration is of more importance than to builders. In estimating the cost of proposed work, and in valuing it when completed; in ordering quantities of materials from merchants, and in estimating the time required to perform the work; in ascertaining the loads upon girders and columns, and the weights of the materials themselves—the builder must continually have recourse to the rules of mensuration. The paramount importance of this branch of the subject is therefore self-evident, and no young workman in any branch of the trade can consider himself competent until he can perform the necessary calculations required in ascertaining accurately the quantities of materials required for his work. The simplest rules of mensuration being almost self-evident, no proof need be given. For those which are not so obvious, I think some form of practical demonstration is better adapted to the mental capacities of our students, and is far better appreciated than a rigid mathematical proof. Instead of stating the rules of mensuration in words, as, for example, one finds in the older text-books, such as Todhunter's, I prefer to adopt Professor Perry's system, and give them as simple algebraical formulæ. After an elementary introduction to algebra, I find our men readily work from such formulæ. This system avoids burdening the memory with cumbersome rules, difficult to remember, whilst the student learns that such formulæ may be modified in accordance with the ordinary rules of algebra, and so adapted to the particular work in hand. For example, the old rule for finding the area of a triangle when three sides are given, although simple when expressed algebraically, as $A = \sqrt{s(s-a)(s-b)(s-c)}$, assumes rather a forbidding aspect when stated verbally, and is not easily remembered. Of course the teacher will see that examples are worked by the decimal method as well as by the use of vulgar fractions, whilst of still greater importance is the duodecimal method so universally employed by

quantity surveyors. I certainly think that until the metric system is more generally adopted in practice we need not take up the very limited time available in evening classes for the purpose of teaching the principles and practice of that admirable system.

III. *Geometry.*

We come now to that branch of mathematics which to our men may fairly be regarded as the most important one, not only because it lays the foundation upon which the whole science of mensuration is built, but also because it provides the necessary basis for the construction and use of all working and detail drawings, as well as for the setting out of the work itself. Although, however, we are so dependent upon the work of pure geometry, I think it is neither necessary nor wise to attempt to teach our trade lads rigid geometrical proofs, such as Euclid would insist upon, for every problem we give them. The great majority of them have neither the time nor the ability to go through a logically arranged course of pure geometry; and even if they were to take such a course, I doubt whether one-tenth of them would be able to adequately apply their knowledge to their daily work. To my mind it is of far greater importance to give them a thoroughly good and fairly complete course of practical geometry, dealing with plane geometry first, and then following with the projection of solids, and finally giving them a good grounding in the practical geometry of points, lines, and planes.

It should here be observed that the geometry required is not merely that minimum which is necessary to enable a man to understand or construct a working drawing, but must go far enough to enable him to set out his own work upon the material, and must prepare him for attacking the more difficult problems of his trade, such as circle upon circle, and oblique work generally. To masons, bricklayers, carpenters and joiners, and, to some extent, to plumbers as well, it is of the first importance that they should have a good knowledge of practical plane and solid geometry if they are ever to become competent workmen, able to deal satisfactorily with the higher branches of their trade.

We have but to think of the setting out of staircases and handrails in joinery, of complicated hipped roofs in carpentry, of vaults, domes, and skew bridges in masonry, together with all the bevels and templates incidental thereto, in order to see the supreme importance of practical geometry to the builder. The course of geometry which will best meet the requirements of our men is therefore, I think, one in which the drawing board and T square are freely and continuously employed in class.

Beginning with simple exercises in the bisection of lines and angles, with applications thereof, we should proceed to various useful problems on the straight line and circle, and the construction of triangles and polygons, simple problems on areas, on proportion and similar figures, and the construction of various useful curves, such as ellipses, parabolas, and spirals. Every lesson must suggest some direct practical application to actual work, if we are to retain the interest of our students. Two methods should sometimes be given for the solution of the same problem—one for use on the drawing board, and another to be used in setting out work full size in the workshop. Following the plane geometry will come several lessons upon simple solids drawn in plan and elevation, together with various sections of them by vertical, horizontal, and inclined planes. Solids, such as bricks, suggestive of actual work, always seem to have a greater fascination for our men than the more academical tetrahedrons, cubes, octahedrons, &c. Developments of solids should be fully dealt with, since, for instance, the templates required in setting out masonry are derived directly from developments of the intended finished forms.

In order to be fully prepared for dealing with the higher branches of constructive work, including bevelled, splayed, and oblique work, circle upon circle, and generally work of double curvature, the student should have a good course dealing with points, lines, and planes in space, showing methods for determining their intersections, the true lengths of lines, real angles between planes, &c. He will then be able to apply his knowledge to the particular work in hand, and often to devise his own methods.

I regret to find that the Board of Education Syllabus in practical plane and solid geometry at the present day is far less fitted to meet the requirements of builders than it was ten or twenty years ago. In place of the really useful problems on points, lines, planes, and solids, one finds a miscellaneous assortment of work, including graphic arithmetic, vectors, the tracing of loci, graphic representation of trigonometrical functions, and much besides, which may be very useful to engineers, and would afford an excellent course of mental training to architects, if they had the time and inclination to undertake it; but as far as actual building work is concerned, one half of it is simply useless to our men, for not one in a thousand of them would ever require to make use of it in his daily work. The text-book on geometry which I think most nearly meets the requirements of builders is the excellent Advanced Practical Plane and Solid Geometry written by the late Mr. Henry Angel. The ground is fairly well covered, and if a few more examples could be added showing the application of practical geometry to problems met with in building work it would be a greater favourite among workmen than it is at present. Like Prof. Perry, I would not draw a hard-and-fast line between geometry and arithmetic. Practical problems should be solved by the readiest and best methods that suggest themselves, whether

geometrical or arithmetical; whilst a mixed method may often be used with advantage.

Regarding geometrical proofs, as I have already hinted, I often prefer an optical demonstration to a strict mathematical proof for the class of men we have to deal with. Thus in problems upon areas, such as finding a rectangle equal to a given triangle, or making a rectangle equal to a given parallelogram, the teacher may cut the given figures out of paper, and by dissecting them properly may build up the required figures out of the pieces so obtained. Again, to verify Euclid, i. 47, right-angled triangles may be taken having sides in the ratio 3 : 4 : 5 or 8 : 15 : 17, and the area of each square shown by cutting it up into square units. When dealing with this problem it should be pointed out that the truth holds good for all similar figures, and an illustration may be given for circles in determining the diameter of a pipe which shall have the same sectional area as two or more given pipes.

Perhaps a few words should be said upon the use of squared paper and the construction of graphs. It appears to me that for builders this kind of work has a far more limited field of usefulness, and is of much less importance than for engineers. I certainly think that the more advanced students should be taught to understand and make intelligent use of diagrams on squared paper when necessary, but beginners in their first year need spend no time upon them. In the advanced stages of technical subjects I find that diagrams to illustrate physical laws, and expressing the results of experiments as curves, are readily understood by our students. In this way they have been of great assistance to me in bringing home to a class in an interesting way many important facts connected with the testing and properties of building materials. I think, however, that the only section of our students who would find it worth their while to pursue the subject beyond this point are those who are likely to become leading draughtsmen, managers, or principals of firms.

Now with reference to vectors and graphic statics. Since, with the exception of problems connected with the transport and hoisting of materials, and perhaps the occasional driving of a few piles, builders are concerned with the statical branch only of mechanics, I think the time which would be spent in adequately teaching our men how to deal effectively with problems on velocities and accelerations, circular motion, &c. would be better spent if devoted to other subjects, which to them would be of greater interest and of more practical importance. I would therefore deal only with the triangle and parallelogram of *forces*, as concrete and specific examples of the more general theory of vectors, perhaps occasionally showing an intelligent class that the same treatment could be applied to problems on motion and position.

The only branch of the subject which is likely to be of practical utility to our men, and which, I think, should be dealt with thoroughly and in a fairly exhaustive manner in the higher stages, is that which deals with statical problems in framework and masonry. Closely associated with this work is the determination of bending moment and shearing force diagrams for beams; of centres of gravity and moments of inertia for plane figures; of resistance lines in arches and retaining walls, and of resistance areas in beams—all of which are useful in the higher stages of building construction. Even here, however, we must bear in mind that but very few of the craftsmen in our trade classes are ever likely to have to design structural work of any magnitude for themselves. This subject is pre-eminently one for the civil engineer, the architect, and the surveyor with their assistants.

In teaching this branch of the subject I have found that practical men have no difficulty in grasping the meaning of force scales and in using them. Bending moment scales are a general stumbling block to all, on account, I presume, of the abstract conception of a mechanical moment being more difficult to realise than that of a simple force. Even where Bow's admirable system of notation is employed, beginners generally experience great difficulty in drawing stress diagrams for framed structures. The idea often prevails that the diagrams can be learnt by heart in the same way that boys at school sometimes learn Euclid's figures.

Doubtless many of those present will be disappointed at the limited view I am now taking of the part which mathematics should play in the training of our artisans. Let it be clearly understood that I am not dealing with the case of boys in technical day schools, for whom, no doubt, a more liberal syllabus in many respects would prove advantageous. I have endeavoured to confine my remarks to the work required in evening classes. Just as soldiers are admonished to aim low if they would shoot effectively, so I am more convinced every year that the true secret of effective teaching to artisans is to curb ambition in our constant endeavour to ensure that fundamental principles are well understood.

Let us remember that, after all, our ultimate object should be not merely to prepare students for passing examinations based on ambitious syllabuses, nor to turn out trained mathematicians, but to fit them for grappling successfully with the hard practical problems of everyday life; to make them not merely clever calculators, but good all-round craftsmen, able to turn out a piece of work with credit to themselves and their employers; to turn out men not just barely able to hold their own in the world, but well qualified to advance their own interests as well as the interests of their trade, and so prove, not only successful competitors in the struggle for existence, but masters of their craft in the full sense of the word—men many of whom may rise to responsible and useful positions in life, and so prove a blessing to the whole community.